

THE WEATHER AND CIRCULATION OF AUGUST 1967

Unusually Cool East of the Rockies and Very Warm in the Far West

JULIAN W. POSEY

Extended Forecast Division, Weather Bureau, ESSA, Suitland, Md.

1. MEAN CIRCULATION

The longwave pattern in the vicinity of the United States changed very little from July to August (fig. 1 and [1]). A ridge over the western half of the country persisted, and the associated 700-mb. positive height anomaly center located over Idaho in July increased from 130 to 200 ft. as it shifted northward into Canada (fig. 2). The trough over the eastern half of the United States also remained about stationary with little change in depth. The positive height anomaly to the east over the western Atlantic continued in the same location also, the central value changing from 190 to 210 ft. At higher latitudes over North America more change was evident. Flow that had been fairly zonal and somewhat cyclonic over Northwest Canada became strongly anticyclonic, as the western ridge amplified. Resulting downstream effects were the deepening of the northern portion of the stationary eastern trough and the changing of a weak positive height anomaly center over Baffin Island in July to a 200-ft. negative anomaly in August.

Over the eastern Atlantic, a trough in about the same location as during July became broader with the associated negative height anomaly center being weaker and farther south in August. The long term slowly retrograding high latitude block over Asia [1] merged with the relatively weak July ridge near the Caspian Sea, resulting in a strongly amplified ridge from the Arctic Basin to the Persian Gulf. Along the east coast of Asia the trough at high latitudes deepened, while to the south over southern Japan and China an east-west ridge grew stronger.

The largest July to August change in the 700-mb. circulation occurred in the Central Pacific near the Aleutian Islands, where a 390-ft. positive anomaly was virtually eliminated and replaced by a 300-ft. negative anomaly slightly to the east. The Arctic Basin Low continued deeper than normal in about the same location as in July, but the anomalous height departure and the actual depth of this Low were less in August.

2. TEMPERATURE

This was one of the coolest Augusts of record in the Nation's mid-section and some of the East, and one of the

warmest in the Far West (fig. 3 and tables 1 and 2), continuing the same basic temperature pattern that was established in July. Not only were the temperature regimes in the two areas extreme in the average, but they were persistently so. A graph of the daily temperature anomalies at two of the more extreme stations (one in the cool area and one in warm area) clearly shows this persistence (fig. 4). A second and very interesting characteristic of the graphs in figure 4 is their phase relationship for most of the month. Further investigation is needed to explain this phenomenon.

TABLE 1.—Record low monthly mean temperatures for August established in 1967

Station	Mean Temperature (°F.)	Departure From Normal (°F.)
Birmingham, Ala.	74.2	-6.9
Montgomery, Ala.	78.4	-3.3
Athens, Ga.	75.1	-3.9
Macon, Ga.	76.5	-4.8
Rockford, Ill.	66.1	-6.4
Evansville, Ind.	70.1	-7.2
Waterloo, Iowa	65.2	-6.5
Flint, Mich.	64.8	-4.8
Jackson, Miss.	77.0	-5.0
Meridian, Miss.	77.0	-4.2
Vicksburg, Miss.	77.1	-4.6
Toledo, Ohio	65.4	-5.5
Columbia, S.C.	75.7	-4.8
Greenville-Spartanburg, S.C.	74.2	-4.0
Chattanooga, Tenn.	73.6	-6.2

TABLE 2.—Record high monthly mean temperatures for August established in 1967

Station	Mean Temperature (°F.)	Departure From Normal (°F.)
Bakersfield, Calif.	87.7	+7.8
Long Beach, Calif.	80.1	+7.8
Los Angeles, Calif. (Civic Center)	79.2	+6.1*
Mount Shasta, Calif.	71.7	+5.0
Sacramento, Calif.	79.7	+7.1*
Stockton, Calif.	81.3	+5.1
Missoula, Mont.	71.2	+6.4
Medford, Oreg.	78.0	+7.3*
Pendleton, Oreg. (Airport)	79.7	+7.8
Pendleton, Oreg. (City)	76.6	Anomaly not given
Portland, Oreg.	75.0	+6.9
Salt Lake City, Utah (City)	78.6	+4.1
Olympia, Wash.	68.8	+5.4
Seattle, Wash.	70.6	+5.6
Stampede Pass, Wash.	64.8	+9.2
Walla Walla, Wash.	80.9	+7.1

*Warmest month of record.

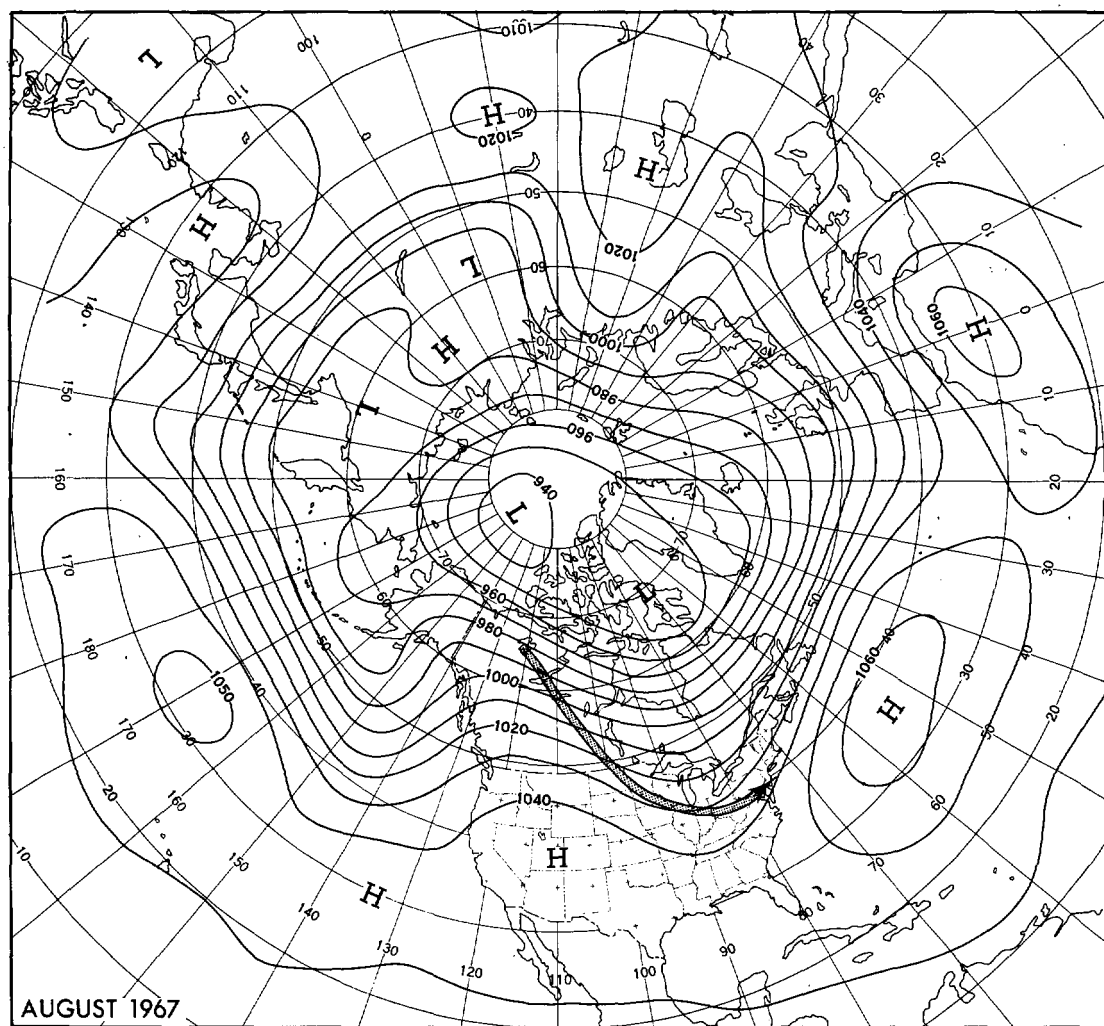


FIGURE 1.—Mean 700-mb. contours (tens of feet), August 1967. Arrow indicates mean path of frequent sea level anticyclones moving into the United States.

The warmth in the West was associated with the strong upper level ridge centered over that area and the easterly anomalous flow (fig. 2). Frequent outbreaks of cool polar air along the mean anticyclone track shown in figure 1 were deployed southward into the United States by the stronger than normal northerly flow from the Rockies to the Ohio Valley to account for the cool weather east of the Rockies. There were six major anticyclones that entered the country this month, and a majority of these reached their maximum intensity in the United States where peak central pressures ranged from 1024 to 1034 mb.

In addition to the transitional zone between the extreme warmth of the west and the extreme coolness to the east, temperatures along much of the Atlantic and Pacific Coasts were also in the in-between category. Sea-breeze effects moderated the West Coast warmth, and southerly

anomalous flow and near normal 700-mb. heights accounted for the near normal temperature areas in the East. Caribou, Maine, with $+1.7^{\circ}$ F., had the largest positive temperature departure in the East, which was in keeping with the southerly anomalous flow and the larger positive height anomaly in this area (fig. 2). Sea-breeze effects also played a part in keeping the southern New England coast and the Middle Atlantic coast about 2° F. below normal. Here mean upper level flow might have indicated a warmer regime in the absence of any ocean temperature contrasts.

3. PRECIPITATION

Very heavy precipitation fell over most areas to the east of the persistent mean trough (figs. 1 and 5), as the extremely cool air forced the northward moving warm

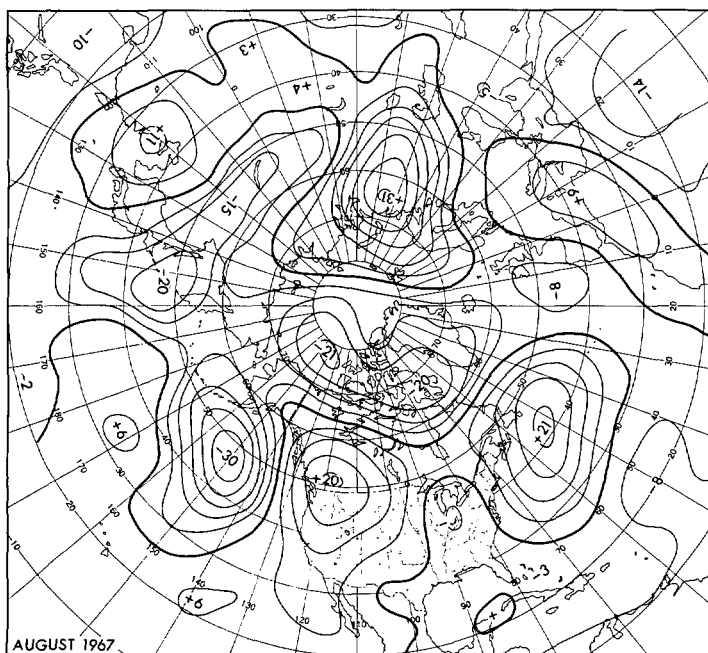


FIGURE 2.—Departure from normal of mean 700-mb. heights (tens of feet). August 1967.

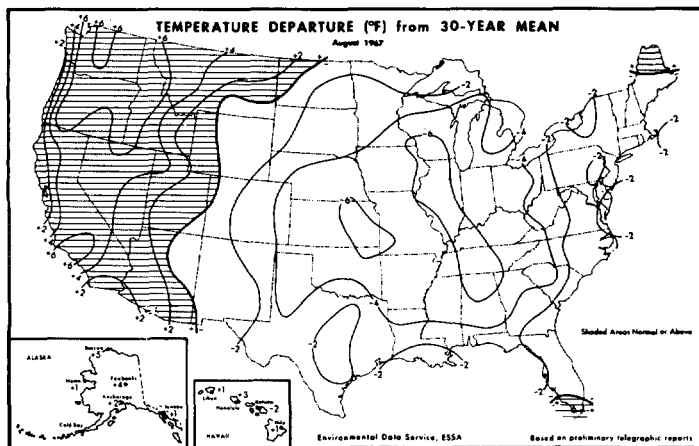


FIGURE 3.—Surface temperature departures from normal ($^{\circ}\text{F}.$), August 1967 (from [2]).

moist air aloft. Local flooding was reported from many areas in the East.

To the west of the mean trough in much of the Central Mississippi Valley and in large areas of the Plains precipitation was relatively light, mainly because the persistent northerly flow prevented an intrusion of moist air from the Gulf of Mexico. Some parts of the Northern Plains reported a record dry August. Upslope motion over the higher terrain by winds on the western side of some of the major anticyclones east of the Rocky Mountains was the main factor in producing heavy precipitation in New Mexico and adjacent areas. Welcome relief from a rather severe drought that has plagued southern Texas this summer was also related to the southerly flow to the west

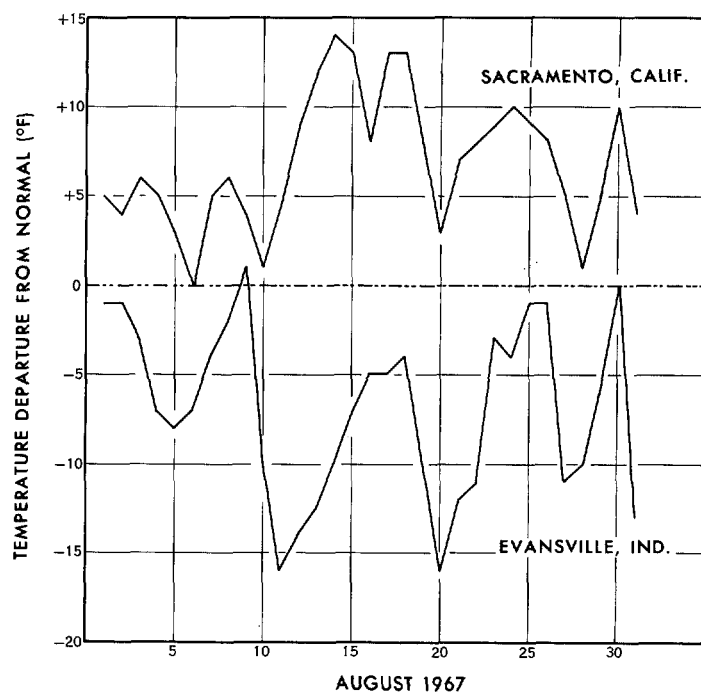


FIGURE 4.—Daily temperature departures from normal ($^{\circ}\text{F}.$) for Sacramento, Calif., and Evansville, Ind., during August 1967.

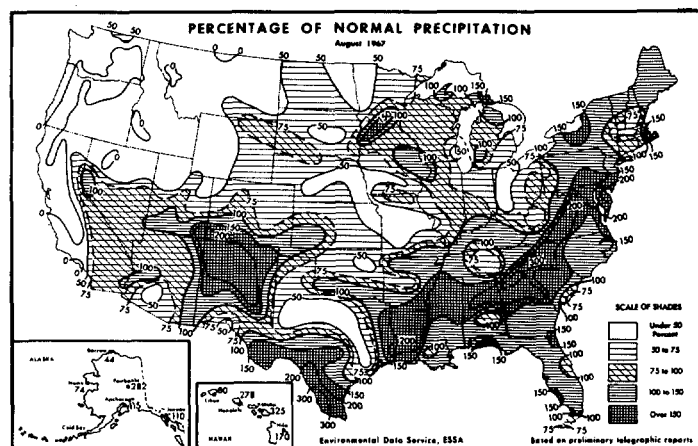


FIGURE 5.—Percentage of normal precipitation, August 1967 (from [2]).

of some strong surface Highs that penetrated to the Gulf of Mexico. However, the Texas rains can better be explained by a shorter period mean circulation and will be discussed in a later section.

In most of California and the Northwest, little or no rain fell this month owing to the dry subsiding air in the strong mean ridge over the West. Serious and damaging forest fires resulted from the extended rainless period in the Northwest. At the end of August, the period without measurable precipitation ranged from 2 to 3 months over much of Oregon and extreme eastern Washington.

Unusually heavy rains fell in the inland sections of Alaska this August. According to [2], "Disastrous floods hit Fairbanks, Alaska, and the smaller community of

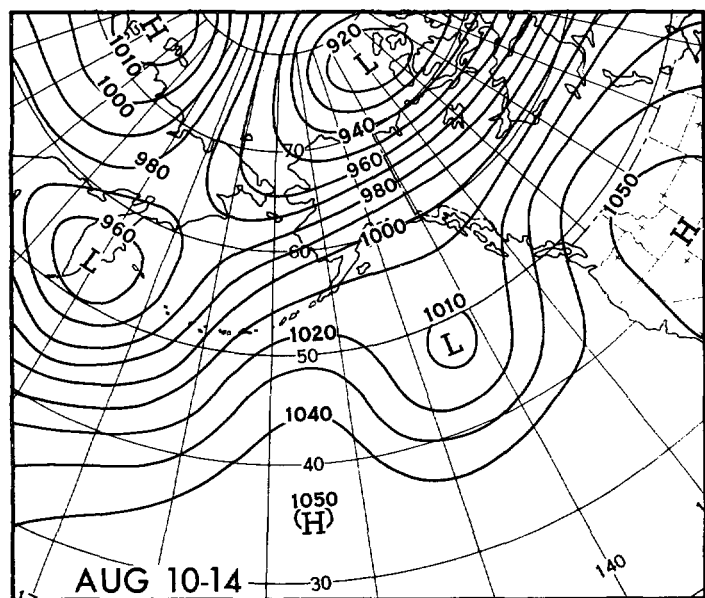


FIGURE 6.—700-mb. contours (tens of feet), August 10–14, 1967. Strong confluence is indicated over Alaska between cold Arctic air and warm, moist Pacific air.

Nenana . . . Fairbanks, much of which lies in the flood plain between the Chena and Tanana Rivers, was almost completely inundated . . . Seven people were known dead and preliminary estimates of property damage ranged from \$150 to \$200 million."

These heavy rains were the result of confluence between a strong northerly flow of air from the Arctic Basin and a southwesterly current of warm moist air from the Pacific (fig. 6) with the warmer air being forced aloft by the colder air as well as the mountains on the headwaters of the rivers flowing through the Fairbanks area. The resulting condensation caused by the cooling of the rising moist currents gave record amounts of rainfall. The 4-day total at Fairbanks from the 11th through the 14th (note the dates on figure 6) was 5.45 in., more than twice the normal August precipitation of 2.20 in. The total August rainfall at Fairbanks was 6.20 in., which is more than half the average annual precipitation of 11.7 in.

4. VARIABILITY WITHIN THE MONTH

August circulation in the vicinity of the United States began as it ended with a ridge in the West and a trough in the East, and the basic wave pattern remained essentially the same in the intervening weeks (figs. 7–10). However there were some variations that brought about fairly large fluctuations of the temperature at individual stations (fig. 4) and lesser changes in the temperature anomaly pattern. Similar changes occurred in the precipitation fields.

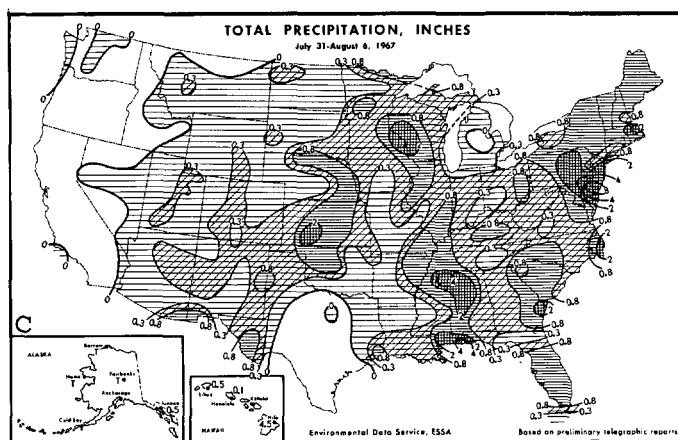
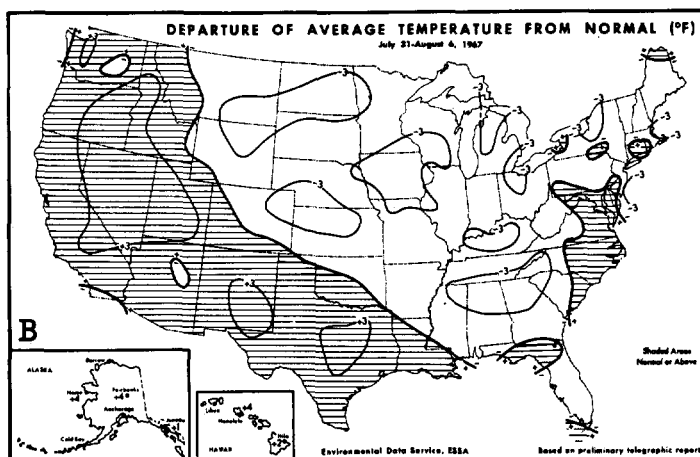
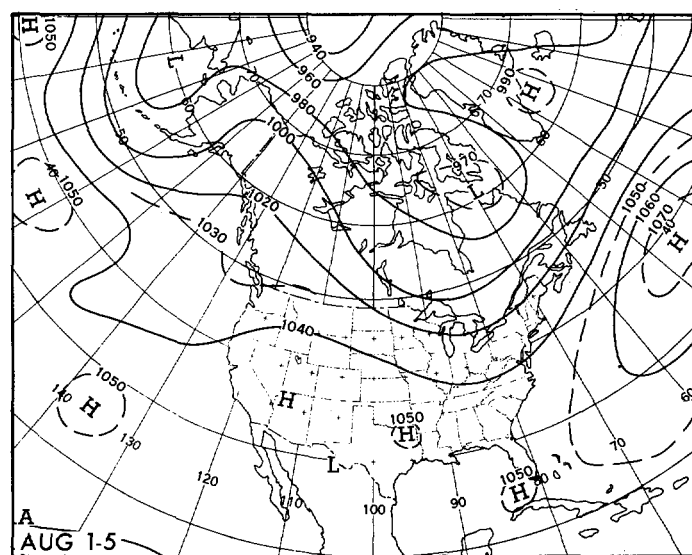


FIGURE 7.—Week of July 31–August 6, 1967: (A) 700-mb. contour (tens of feet), August 1–5, 1967; (B) surface temperature departures from normal (°F.); (C) total precipitation (in.); (B) and (C) from [2].

During the first week of August above normal temperatures were present in the Southern Plains, portions of the eastern seaboard, and most areas west of the Rocky

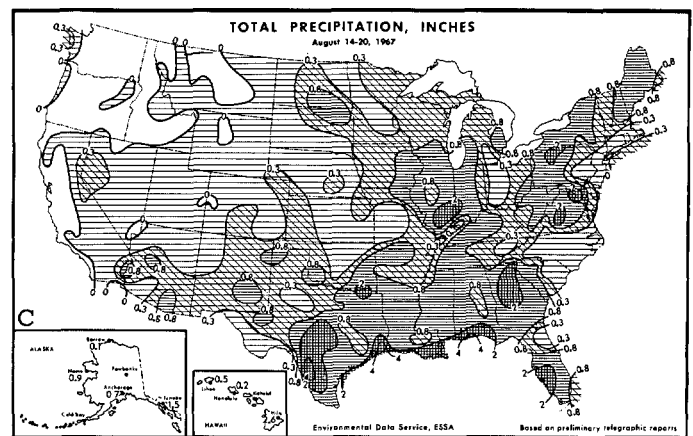
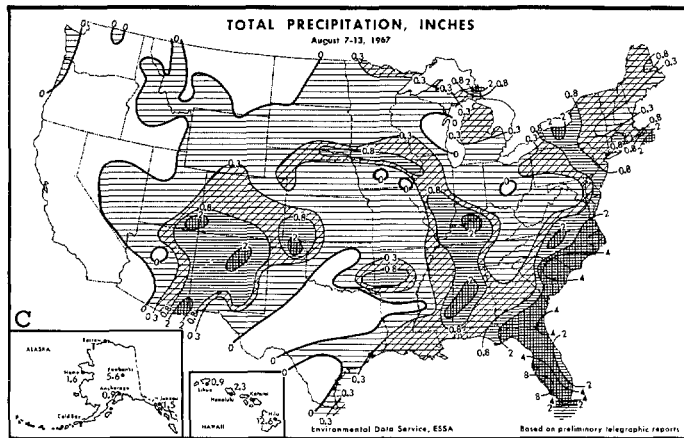
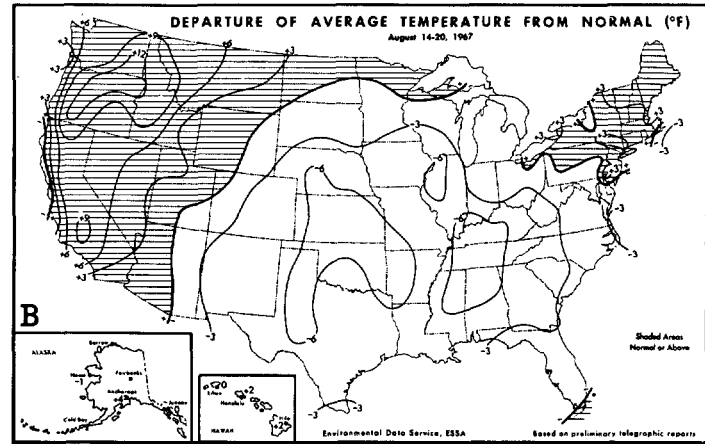
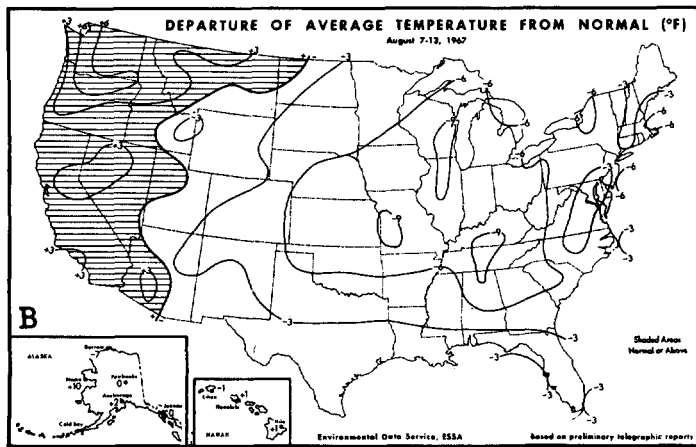
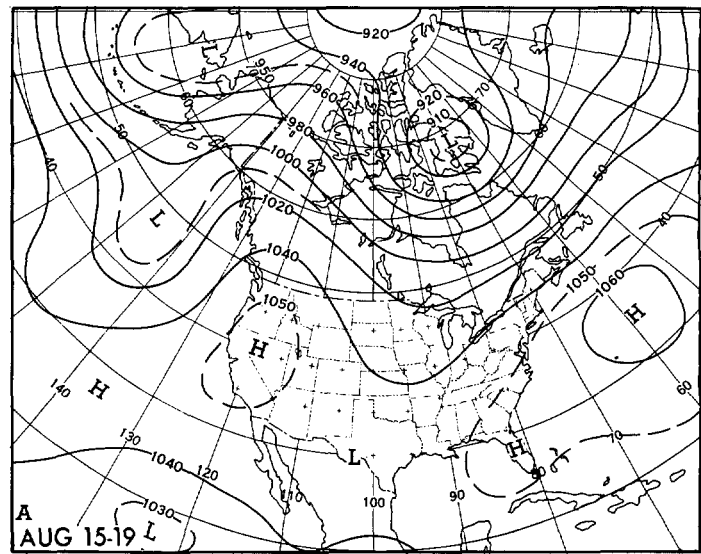
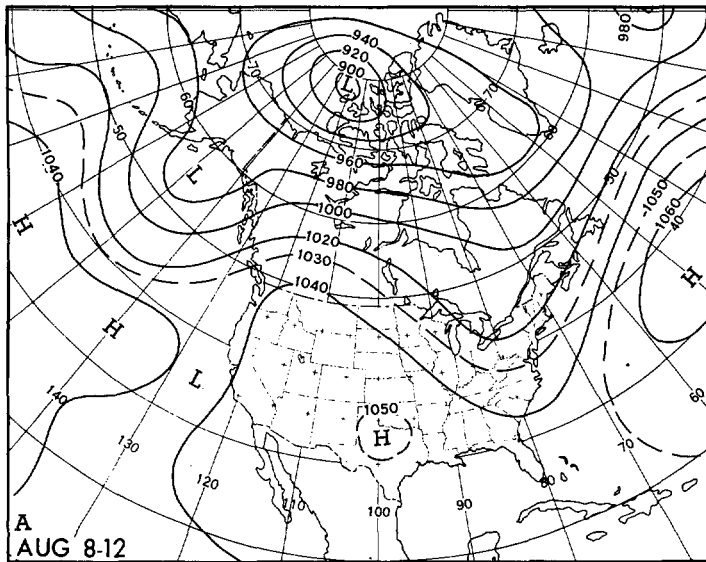


FIGURE 8.—Week of August 7-13, 1967: (A) 700-mb. contours (tens of feet), August 8-12, 1967; (B) and (C) same as figure 7.

FIGURE 9.—Week of August 14-20, 1967: (A) 700-mb. contours (tens of feet), August 15-19, 1967; (B) and (C) same as figure 7.

Mountains (fig. 7B). No very large extremes were present this week, ranging from about three degrees above to three degrees below normal. Precipitation (fig. 7C) occurred mostly with a front that moved steadily south

and east across the country during the week from the Northern Plains and a second front just entering the northern states at the end of the week. However, much of the very heavy rain in southern New Jersey and nearby

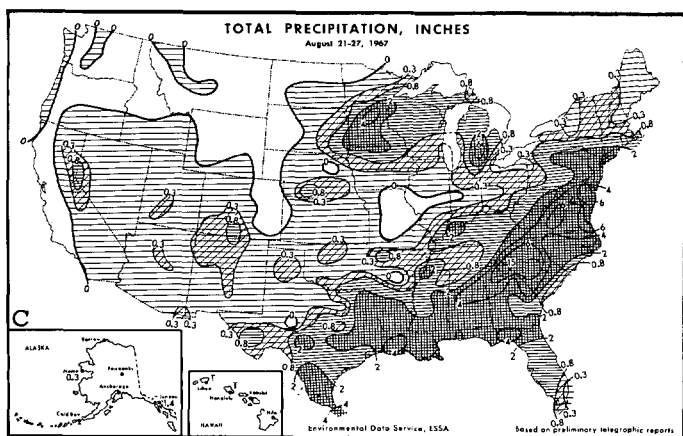
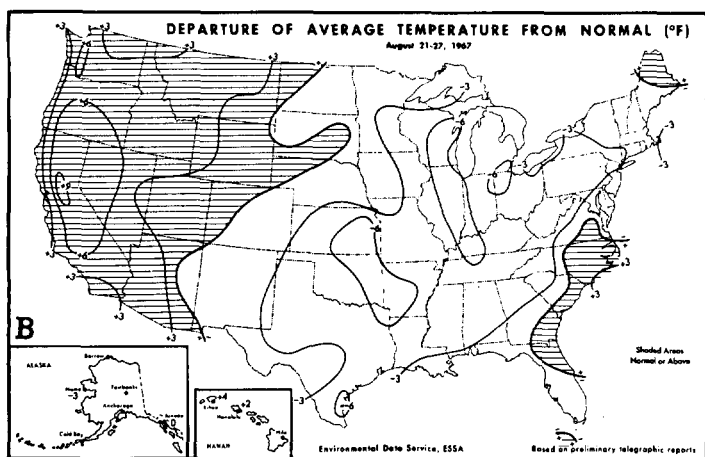
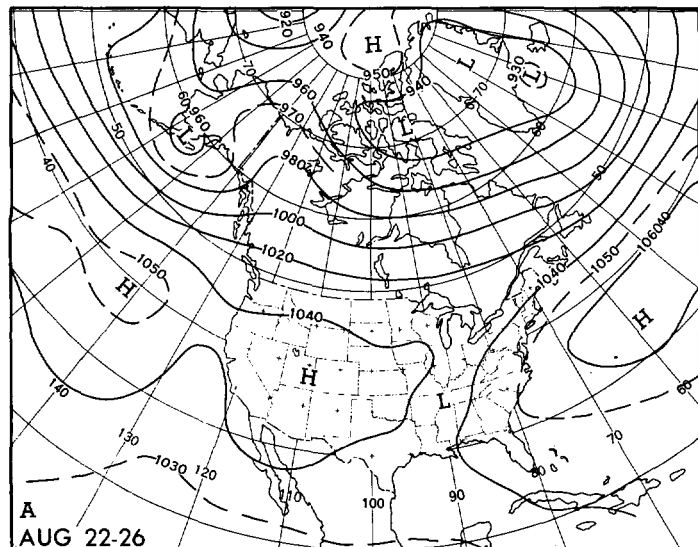


FIGURE 10.—Week of August 21–27, 1967: (A) 700-mb. contours (tens of feet), August 22–26, 1967; (B) and (C) same as figure 7.

areas occurred in air mass thunderstorms well in advance of the front. As much as 6.95 in. fell in the Atlantic City, N.J., area on the 3d, then the same section reported 2.19 in. the next day as the front approached.

TABLE 3.—Record daily minimum temperatures

Station	Temperature (° F.)	Date
Denver, Colo.....	51	15
Rome, Ga.....	50	16
Peoria, Ill.....	59	11
Springfield, Ill.....	55	14
Evansville, Ind.....	57	15
Lexington, Ky.....	51	11
Lansing, Mich.....	48	13
Sault Ste. Marie, Mich.....	50	11
Duluth, Minn.....	47	12
Minneapolis-St. Paul, Minn.....	46	28
St. Cloud, Minn.....	50	11
Springfield, Mo.....	50	20
St. Louis, Mo.....	54	11
Grand Island, Nebr.....	40	11
Aberdeen, N. Dak.....	38	12
Bismarck, N. Dak.....	41	13
Cleveland, Ohio.....	38	23
Toledo, Ohio.....	40	11
Oklahoma City, Okla.....	38	12
Tulsa, Okla.....	39	19
Erie, Pa.....	37	20
Columbia, S.C.....	37	31
	41	10
	41	11
	37	31
	39	19
	44	27
	41	31
	43	10
	48	11
	44	12
	47	13
	53	14
	50	19
	47	20
	47	27
	55	28
	54	13
	56	14
	54	27
	49	31
	43	31
	38	19
	38	27
	45	4
	44	12
	47	13
	48	6
	48	11
	45	12
	44	31
	56	12
	54	13
	60	14
	52	12
	54	13
	53	20
	53	28
	51	11
	48	12
	48	31
	56	14
	56	15

TABLE 4.—Record daily maximum temperatures

Station	Temperature (° F.)	Date
Helena, Mont.....	97	19
Milford, Utah.....	96	20
Spokane, Wash.....	98	23
Walla Walla, Wash.....	98	21
Yakima, Wash.....	96	22
	98	24
	99	25
	96	26
	100	16
	100	17
	101	18
	100	31
	105	16
	105	17
	101	30
	101	17
	98	30

During the second week of August the western ridge amplified, and the trough to the east progressed slightly and deepened in the southern portion (fig. 8A). This amplification was accompanied by the second surge of cool

surface air from Canada, which lowered temperatures over most areas east of the Rocky Mountains (fig. 8B). Many daily minimum temperature records were set this week (table 3). The advancing mean trough in the East resulted in quite heavy rain along the southeast coast, while precipitation in the central part of the country occurred along the leading edge of the advancing cool air.

Continued amplification of the western ridge occurred during the third week with some retrograde motion (fig. 9A). This triggered a retrogression of the eastern trough to slightly west of the Great Lakes, and the formation of a low pressure center at 700-mb. over western Texas. The Far West became extremely hot and continued mostly dry (figs. 9B and 9C). Maximum temperature records were established at several stations (table 4). A warming trend also spread across the northern border states with the colder air, relative to normal, being secluded to the south over the eastern two-thirds of the country. The upper level Low over Texas brought much needed rain to southern Texas. Frontal rain accounted for most of the other significant precipitation.

Progression in the Pacific forced the trough that had been off the coast the previous week into western Canada during the fourth week, causing the upper level flow across Canada to become mostly zonal (fig. 10A). As the Pacific trough moved inland, a diminution of the western warmth occurred (fig. 10B). The Low over Texas also progressed as a function of the flattening western ridge and spread very heavy rain from the Gulf Coast to southern New England. Warming occurred in the Southeast in response to the strong southerly flow in advance of the trough. During the final few days of August reamplification occurred over North America, returning to a pattern (not shown) very similar to figure 8A, again bringing a very strong flux of cool air into the eastern two-thirds of the Nation. There was an extensive 1034-mb. High centered over Minnesota on the August 31 1200 GMT surface chart. Several daily minimum temperature records were set during the last few days of August (table 3).

5. TROPICAL STORMS

Atlantic tropical storm activity was almost nil this August. The first tropical storm in this ocean during 1967 appeared between 20° and 25°N. in the central Atlantic on the 30th. This storm had not become very intense by the end of the month.

In the Pacific, there was much more tropical activity. A total of 15 tropical storms were reported, four in the eastern Pacific and 11 in the western part. Three of the eastern storms moved westward after forming off the Central America Coast and filled. Katrina, the fourth August storm in the eastern Pacific, moved northward and deepened to hurricane strength south of Baja California, on the last day of the month. During the first few days of September, this storm crossed Baja and entered Arizona before losing its identity.

Three of the western Pacific tropical storms formed west of the Philippine Islands and moved into China without reaching typhoon intensity. Two other storms, Marge and Nora, formed east of the Philippines and moved westward, first deepening to become typhoons then weakening to tropical storm status. Marge later became absorbed in Nora's circulation, before Nora moved into China and dissipated. Another tropical storm, Louise, formed east of the Philippines earlier and moved northward to dissipate over Japan. The remainder of the Pacific storms formed farther east and moved northward to become absorbed in the westerlies.

REFERENCES

1. R.R. Dickson, "The Weather and Circulation of July 1967—Unusually Cool East of the Divide," *Monthly Weather Review*, vol. 95, No. 10, Oct. 1967, pp. 700-704.
2. Environmental Data Service, ESSA, *Weekly Weather and Crop Bulletin*, vol. 54, Nos. 32-35 and 37, Aug. 7, 14, 21, 28 and Sept. 11, 1967, pp. 1-8.